# INDOOR AIR QUALITY ASSESSMENT

**Ralph B. O'Maley Middle School**
**32 Cherry Street**
**Gloucester, Massachusetts**

Prepared by:
Massachusetts Department of Public Health
Center for Environmental Health
Emergency Response/Indoor Air Quality Program
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## Background/Introduction

At the request of Brian Tarr, Assistant Superintendent for the Gloucester School Department (GSD), the Massachusetts Department of Public Health (MDPH), Center for Environmental Health (CEH) provided assistance and consultation regarding indoor air quality concerns at the O'Maley Middle School (OMS) in Gloucester, Massachusetts. The request was prompted by reports of occupant complaints of symptoms (e.g., nausea, headaches, dryness, skin irritation, respiratory irritation, odors) and concerns over a possible connection to environmental conditions within the building, most notably periodic sewer gas odors.

On January 4 and 5, 2006, the OMS was visited by Cory Holmes, Environmental Analyst of CEH's Emergency Response/Indoor Air Quality (ER/IAQ) Program, to conduct an indoor air quality assessment and meet with staff to discuss environmental health concerns. The OMS was visited by MDPH in April 2002 and a report was issued that made recommendations regarding IAQ issues observed at the time (MDPH, 2002a). MDPH staff revisited the OMS in June 2002 specifically to conduct an evaluation of the gymnasium and surrounding areas due to concerns of possible mold growth. The findings and recommendations concerning the gymnasium and vicinity were the subject to a separate report (MDPH, 2002b).

In September 2003, the GSD provided information to the MDPH detailing steps that had been taken at OMS in response to MDPH's recommendations. In December, 2003 MDPH staff returned to the building at the request of the GSD to conduct a reassessment of IAQ conditions. A report was issued detailing progress along with some additional recommendations to further improve IAQ (MDPH, 2003). MDPH reports previously issued are available at http://www.state.ma.us/dph/beha/iaq/iaqhome.htm.

In the Spring of 2005 the OMS was visited by the Massachusetts Department of Labor and Workforce Development (MDLWD), Division of Occupational Safety (DOS) to investigate poor air quality complaints from occupants. DOS prepared a report containing a number of recommendations similar to those previously provided by MDPH. In response to previous MDPH and MDLWD recommendations the GSD has instituted a protocol to report and track IAQ/ventilation issues in the form of a School Symptom Report. In addition, work order requests are provided for maintenance/building related problems.

## Methods

Air tests for carbon monoxide, carbon dioxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor, Model 8551. Air tests for airborne particle matter with a diameter less than 2.5 micrometers were taken with the TSI, DUSTTRAK™ Aerosol Monitor Model 8520. Screening for total volatile organic compounds (TVOCs) was conducted using a Thermo Environmental Instruments Inc., Model 580 Series Photo Ionization Detector (PID). Air tests for ultrafine particulates (UFPs) were taken with the TSI, P-Trak ™ Ultrafine Particle Counter Model 8525. Moisture content of wall materials in the auditorium was measured with a Delmhorst, BD-2000 Model, Moisture Detector equipped with a Delmhorst Standard Probe. MDPH staff also performed a visual inspection of building materials for water damage and/or microbial growth.

MDPH focused IAQ monitoring and observation in the areas where complaints were received (i.e., the gymnasium, auxiliary gym, locker rooms; rooms 129, 130, 211, 212, 218, 219, 221, 223). These areas were surveyed several times during the course of the school day on both January 4 and 5, 2006.

## Results

This school has a student population of approximately 900 and a staff of approximately 120. Tests were taken during normal operations at the school and results appear in Tables 1 and 2.

## Discussion

### Ventilation

It can be seen from the tables that carbon dioxide levels were elevated above 800 parts per million (ppm) of air in seven of twenty-eight areas surveyed on January 4, 2006 and in seven of thirty-one areas on January 5, 2006, indicating adequate air exchange in most areas surveyed during the assessment. Classrooms with elevated carbon dioxide mainly consisted of perimeter classrooms where mechanical ventilation is provided by unit ventilator systems in combination with wall or ceiling-mounted exhaust vents. These systems have been described in detail in previous MDPH reports (MDPH, 2002a; MDPH, 2003).

The univent and exhaust vents in classroom 121 were not operating during the assessment, therefore no means of mechanical ventilation was being provided. Obstructions to airflow, items on or in front of univents and exhaust vents were still seen in a few classrooms. As discussed in previous MDPH reports, for univents and exhaust vents to provide air exchange as designed, they must remain free of obstructions and allowed to operate while rooms are occupied.

Although repairs have been made over the years, univents and air handling units (AHUs) are pieces of original equipment that are approximately 30 to 35 years old. Function of such equipment is difficult to maintain due to decreased operating efficiency and the difficulty of obtaining compatible replacement parts. Univents are equipped with non-pleated filters of a low to medium efficiency (Picture 1). However, it is important to note that increased filtration (e.g., upgrading to higher efficiency filters) can reduce airflow produced by increased resistance, a condition known as pressure drop. Prior to any increase of filtration, univents should be evaluated by a ventilation engineer to ascertain whether they can maintain function with filters that are more efficient.

Fresh air in interior classrooms and common areas is provided by air handling units (AHUs) located in mechanical rooms. Air is drawn in through fresh air intakes, which passes through a bank of high efficiency pleated air filters and then through bag filters that screen out fine particulates (Pictures 2 and 3). Air is distributed to occupied areas by ceiling-mounted air diffusers and then returned to the units via ceiling-mounted grills. These units were operating during the assessment and appeared to have generally good air exchange (i.e., carbon dioxide levels ≤ 800 ppm).

The Massachusetts Building Code requires a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week based on a time weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information concerning carbon dioxide, please consult Appendix A.

Temperature readings ranged from 64$^{o}$ F to 76$^{o}$ F, during the January 4, 2006 visit and from 60$^{o}$ F to 75$^{o}$ F, during the January 5, 2006 visit, which were below the MDPH comfort guidelines in a number of areas on both days of the assessment. The MDPH recommends that indoor air temperatures be maintained in a range of 70$^{o}$ F to 78$^{o}$ F in order to provide for the comfort of building occupants. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply. A number of temperature control/comfort complaints were reported to the GSD via the symptom survey. Excessive heat complaints in classroom 219 were expressed to MDPH staff during the January 4, 2006 visit. During the assessment, Dave Anderson, HVAC Technician for the GSD, replaced the thermostat, which was determined to be faulty.

Relative humidity measurements ranged from 20 to 34 percent, during the January 4, 2006 visit and from 29 to 47 percent, during the January 5, 2006 visit. These readings were below the MDPH comfort guidelines in all areas surveyed on January 4 and in all but two areas on January 5 (Tables 1 and 2). The MDPH recommends a comfort range of 40 to 60 percent for indoor air relative humidity. Relative humidity levels in the building would be expected to drop during the winter months due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

**Odors**

Occupant complaints related to sewer-gas odors has been well documented by both MDPH and MDLWD since 2002. There appear to be two main sources of these odors: one internal and one external. The external source stems from the operation of a waste water pumping station located approximately 0.3 miles south-southwest from the school (Figure 1).

The role of the pumping station is to transfer waste from the North Gloucester/Wheelers Point area downhill to the gravity drainage system, which may then flow to the waste water treatment plant on Essex Ave. Ms. Christy Millhouse, Wastewater Treatment Plant Coordinator, Gloucester Department of Public Works (GDPW), reported that the pumping station has a large holding tank, which collects the raw sewage until it reaches a certain volume that triggers the pump to activate. Although a rare occurrence, under certain wind and weather conditions, odors generated at the pumping station may drift toward the school and be drawn into the mechanical ventilation system via outside air intakes (Picture 4).

The second odor source is through the dry traps of floor drains in the boiler room, air handling unit rooms, restrooms and locker rooms beneath the gym (Picture 5). Drains are usually designed with traps in order to prevent the back up of sewer odors/gases from penetrating into occupied spaces. When water enters a drain, the trap fills and forms a watertight seal.

Without a watertight seal, odors or other material can travel up the drain and enter the occupied space. The maintenance of drain traps at the OMS requires vigilance due to the large number of traps located on floors throughout the building. There are 55 such traps in the building, which include 25 drains in the girl's locker room, 15 in the boy's locker room, 10 in the boiler room, 3 in the lower AHU room and 2 in the upper AHU room (Picture 6). As a result of on-going issues with odors associated with dry drain traps, GSD officials have instituted a program assigning a specific individual to fill all traps with water twice a week (Picture 6). The program reportedly commenced on December 1, 2005. As of February 24, 2006, MDPH staff confirmed with Dr. Michael Tracy, Principal, OMS that no odors had been reported since the trap filling program was instituted.

During the course of the current MDPH assessment, an undocumented drain was discovered in classroom 223 (Picture 7). This drain was installed to drain condensation from a portable air-conditioning unit located in the computer network room (Picture 8). At the close of the January 5, 2006 visit MDPH staff recommended to GSD officials that the drain in room 223 be added to the list located in the maintenance office (Picture 6). In addition, MDPH staff recommended that the spigot emptying into the drain be extended (e.g., rubber tubing), *into* the drain, to ensure proper drainage.

**Microbial/Moisture Concerns**

A number of areas including classrooms, locker rooms and specialty rooms had missing and/or water-damaged ceiling tiles which can indicate leaks from either the roof or plumbing system (Tables 1 and 2). Water-damaged ceiling tiles can provide a source of mold and should be replaced after a water leak is discovered and repaired. Mold colonized ceiling tiles were observed in the skate storage room (Picture 9). Active roof leaks were observed in the gymnasium near the locker room stairwell and in the hallway that connects the school to the ice rink. Water damaged ceiling plaster was also seen in the gymnasium (Picture 10); it was not possible to discern if the damage was current or evidence of an historic leak.

Periodic leaks were reported by one classroom occupant to occur in room 223 directly below an elbow joint for a drain (Picture 11). The drain itself did not appear to be the source of the leak but rather from a source above the roof deck. Water damaged ceiling tiles were also observed toward the rear of room 223. MDPH staff removed the tiles to examine conditions in the ceiling plenum, and found a section of uninsulated sheet-metal ductwork (Picture 12), which would suggest that condensation on the cool surface of the metal duct may be the moisture source damaging tiles. Occupants also expressed concern relative to whether old plumbing fixtures were sealed in room 223. MDPH staff examined decommissioned plumbing fixtures, which were found to be capped. However, water damaged porous materials were found behind cabinets in these areas, which most likely became wet from overflow during sealing of pipes (Picture 13).

Missing/damaged tiles were observed in classroom 208 as a result of plumbing leaks that had reportedly been repaired just prior to the MDPH assessment. Concerns were also expressed by one occupant regarding staining of walls (Picture 14). MDPH staff recommended to the GSD and maintenance staff that the walls be cleaned and disinfected.

The US Environmental Protection Agency (US EPA) and the American Conference of Governmental Industrial Hygienists (ACGIH) recommends that porous materials be dried with fans and heating within 24 to 48 hours of becoming wet (ACGIH, 1989; US EPA, 2001). If porous materials are not dried within this time frame, mold growth may occur. Cleaning cannot adequately remove mold growth from water-damaged porous materials. The application of a mildewcide to moldy porous materials (e.g., ceiling tiles) is not recommended.

Occupants also reported concerns of mold growth on walls at the rear of the auditorium. The wall is painted black and is covered by a metal screen. A white dusty material was observed on the surface of the wall underneath the grate. The origin of the dusty material could not be identified; however it seemed unlikely that the material was mold, due to lack of a source of moisture (e.g., water leak) that would stimulate fungal growth. All areas examined in the auditorium appeared dry, and no musty/mold-like odors were detected during the assessment. MDPH staff did however conduct moisture testing of the auditorium wall that had the white, dusty material on its surface. As stated, in order for building materials to support mold growth, a source of water is necessary. Identification and elimination of water moistening building materials is necessary to control mold growth. Materials with increased moisture content *over normal* concentrations may indicate the possible presence of mold growth. All areas of the wall material tested were found to have low (i.e., normal) moisture content (Table 1) at the time of the assessment. MDPH staff recommended vacuuming the material off the surface of the wall with a high efficiency particulate arrestance (HEPA) filter equipped vacuum cleaner.

**Other IAQ Evaluations**

Indoor air quality can be adversely impacted by the presence of respiratory irritants, such as products of combustion. The process of combustion produces a number of pollutants. Common combustion products include carbon monoxide, carbon dioxide, water vapor and smoke (fine airborne particle material). Of these materials, exposure to carbon monoxide and particulate matter with a diameter of 2.5 micrometers (μm) or less (PM2.5) can produce immediate, acute health effects upon exposure. To determine whether combustion products were present in the school environment, MDPH staff obtained measurements for carbon monoxide and PM2.5.

Carbon monoxide is a by-product of incomplete combustion of organic matter (e.g., gasoline, wood and tobacco). Exposure to carbon monoxide can produce immediate and acute health affects. Several air quality standards have been established to address carbon monoxide pollution and prevent symptoms from exposure to these substances. The MDPH established a corrective action level concerning carbon monoxide in ice skating rinks that use fossil-fueled ice resurfacing equipment. If an operator of an indoor ice rink measures a carbon monoxide level over 30 ppm, taken 20 minutes after resurfacing within a rink, that operator must take actions to reduce carbon monoxide levels (MDPH, 1997).

ASHRAE has adopted the National Ambient Air Quality Standards (NAAQS) as one set of criteria for assessing indoor air quality and monitoring of fresh air introduced by HVAC systems (ASHRAE, 1989). The NAAQS are standards established by the US EPA to protect the public health from 6 criteria pollutants, including carbon monoxide and particulate matter (US EPA, 2000a). As recommended by ASHRAE, pollutant levels of fresh air introduced to a building should not exceed the NAAQS (ASHRAE, 1989). The NAAQS were adopted by reference in the Building Officials & Code Administrators (BOCA) National Mechanical Code of 1993 (BOCA, 1993), which is now an HVAC standard included in the Massachusetts State Building Code (SBBRS, 1997). According to the NAAQS established by the US EPA, carbon monoxide levels in outdoor air should not exceed 9 ppm in an eight-hour average (US EPA, 2000a).

*Carbon monoxide should not be present in a typical, indoor environment.* If it *is* present, indoor carbon monoxide levels should be less than or equal to outdoor levels. Indoor carbon monoxide concentrations at the OMS were non-detect or ND on both days of the assessment (Tables 1 and 2). Carbon monoxide levels measured outside the school were also ND on both days of the assessment (Tables 1 and 2).

In response to previous concerns regarding carbon monoxide (CO) exposure, two wall-mounted, battery operated CO detectors were installed in the gymnasium (Picture 15). According to the manufacture's website, carbon monoxide alarms should be replaced every 5 years. In addition, alarms should be tested monthly to ensure proper working order and that batteries be replaced regularly to stay fresh (Kidde: http://www.kiddeus.com/Replace+CO+Alarms.shtml).

As previously mentioned, the US EPA also established NAAQS for exposure to particulate matter. Particulate matter is airborne solids that can be irritating to the eyes, nose and throat. According to the NAAQS, PM10 levels should not exceed 150 micrograms per cubic meter ($\mu g/m^3$) in a 24-hour average (US EPA, 2000a). This standard was adopted by both ASHRAE and BOCA. Since the issuance of the ASHRAE standard and BOCA Code, US EPA proposed a more protective standard for fine airborne particles. This more stringent PM2.5 standard requires outdoor air particulate levels be maintained below 65 $\mu g/m^3$ over a 24-hour average (US EPA, 2000a). Although both the ASHRAE standard and BOCA Code adopted the PM10 standard for evaluating air quality, MDPH uses the more protective PM2.5 standard for evaluating airborne particulate matter concentrations in the indoor environment.

Outdoor PM2.5 concentrations on January 4, 2006 were measured at 16 $\mu g/m^3$ (Table 1). PM2.5 levels measured indoors ranged from 4 to 39 $\mu g/m^3$. Outdoor PM2.5 concentrations on

January 4, 2006 were measured at 48 $\mu g/m^3$ (Table 1). PM2.5 levels measured indoors ranged from 4 to 52 $\mu g/m^3$, which were below the NAAQS PM2.5 level of 65 $\mu g/m^3$ in all areas surveyed on both days of the assessment. Frequently, indoor air levels of particulates (including PM2.5) can be at higher levels than those measured outdoors. A number of mechanical devices and/or activities that occur in schools can generate particulate during normal operations. Sources of indoor airborne particulates may include but are not limited to particles generated during the operation of fan belts in the HVAC system, cooking in the cafeteria stoves and microwave ovens; use of photocopiers, fax machines and computer printing devices; operation of an ordinary vacuum cleaner; and heavy foot traffic indoors.

Indoor air quality can also be impacted by the presence of materials containing volatile organic compounds (VOCs). VOCs are substances that have the ability to evaporate at room temperature. Frequently, exposure to low levels of total VOCs (TVOCs) may produce eye, nose, throat and/or respiratory irritation in some sensitive individuals. For example, chemicals evaporating from a paint can stored at room temperature would most likely contain VOCs. In an effort to determine whether VOCs were present in the building, air monitoring for TVOCs was conducted. Indoor TVOC measurements throughout the building were ND on both days of the assessment (Tables 1 and 2). Outdoor air samples taken for comparison were also ND on both days of the assessment (Tables 1 and 2).

Please note, TVOC air measurements are only reflective of the indoor air concentrations present at the time of sampling. Indoor air concentrations can be greatly impacted by the use of TVOC-containing products. While no measurable TVOC levels were detected in the indoor environment, VOC-containing materials were noted. Several classrooms contained dry erase boards and dry erase board markers. Materials such as dry erase markers and dry erase board cleaners may contain VOCs, such as methyl isobutyl ketone, n-butyl acetate and butyl-cellusolve (Sanford, 1999), which can be irritating to the eyes, nose and throat. Cleaning products were found on countertops and beneath sinks in a number of classrooms. Cleaning products contain VOCs and other chemicals, which can be irritating to the eyes, nose and throat and should be stored properly and kept out of reach of students.

In an effort to reduce noise from sliding chairs, tennis balls had been sliced open and placed on chair legs (Picture 16). Tennis balls are made of a number of materials that are a source of respiratory irritants. Constant wearing of tennis balls can produce fibers and cause TVOCs to off-gas. Tennis balls are made with a natural rubber latex bladder, which becomes abraded when used as a chair leg pad. Use of tennis balls in this manner may introduce latex dust into the school environment. Some individuals are highly allergic to latex (e.g., spina bifida patients) (SBAA, 2001). It is recommended that the use of materials containing latex be limited in buildings to reduce the likelihood of symptoms in sensitive individuals (NIOSH, 1997). A question and answer sheet concerning latex allergy is attached as Appendix B (NIOSH, 1998).

Several other conditions that can affect indoor air quality were noted during the assessment. The OMS has experienced periodic issues with entrainment of vehicle exhaust. Several observations may help to explain this. First, the student drop off area is located directly in front of the building (Figure 2); when busses and cars idle in this area (even if only for a short time) it presents the opportunity for exhaust emissions to be drawn into univent air intakes located along the front of the building. The second factor relates to the area terrain. The access road runs parallel to the building, which leads to a hairpin turn and travels directly in front of the building (Figure 2). The hill creates a trough along the front of the OMS, which is set in a bowl-shaped area next to the hill. Under certain wind and weather conditions the low lying area between the school and the hill can act as a reservoir to collect/trap vehicle exhaust emissions and/or as a result of odors and particulates from other nearby emission sources (e.g., wood stoves and gas furnaces/water heaters, appliances from residences/Figure 2).

The combustion of fossil fuels can produce particulate matter that is of a small diameter (0.1 μm), which can penetrate into the lungs and subsequently cause irritation. For this reason a device that can measure particles of a diameter of 0.1 μm or less was also used to identify pollutant pathways from vehicles into the occupied areas. Inhaled particles can cause respiratory irritation.

To illustrate this occurrence, on January 5, 2006 MDPH staff arrived at the OMS prior to the start of the school day and promptly responded to a complaint of exhaust fume odors in classroom 221, which is located along the front of the building, adjacent to the student drop-off area. The odor of exhaust emissions was prevalent directly outside the building and a UFP measurement of 24,000 particles per cubic centimeter (p/cc$^3$) was recorded; a measurement of 5,700 p/cc$^3$ was measured in classroom 221 (Table 2) MDPH staff revisited the room approximately fifteen minutes later and determined that odors had dissipated along with UFP levels (1,700 p/cc$^3$). Outside UFP levels dissipated to 8,900 p/cc$^3$. This demonstrates that under certain conditions exhaust emissions *outside* the building may be drawn *into* the building. Combustion odors and elevated UFPs were also detected in the kiln room emanating from an open utility hole that shares a common wall with the boiler room (Picture 17/Table 1).

Occupants in the gymnasium had particular concerns regarding accumulated dust, dirt and debris in the storage room (Picture 18), on vents (Picture 19), flat surfaces above the gym floor, and in particular, along the unused track (1-1 $^{1/2}$-inches wide) that separates the gym in half (Picture 20). The divider is reportedly in disrepair and has not been used for several years, allowing dirt, dust and debris to collect in the track. Activity in the gym, coupled with low relative humidity during the heating season can create conditions to reaerosolization these materials, which can serve as eye or respiratory irritants. A number of exhaust and supply vents in classrooms also had accumulated dust (Picture 21). If exhaust vents are not functioning, backdrafting can occur, which can re-aerosolize dust particles. Dust particles can also be aerosolized when the supply system is activated.

In several areas, items were observed on windowsills, tabletops, counters, bookcases and desks (Pictures 22 and 23). The large number of items stored provides a source for dusts to accumulate. These items (e.g., papers, folders, boxes) make it difficult for custodial staff to clean. Items should be relocated and/or be cleaned periodically to avoid excessive dust build up.

Lastly, exposed fiberglass insulation around pipes and open utility holes were observed in the art rooms (Pictures 24 through 26), the auxiliary gym (Pictures 27), room 223 (Picture 7) and as mentioned previously, the kiln room (Picture17). Fiberglass insulation can be a source of skin, eye and respiratory irritation to sensitive individuals. Open utility holes can serve as a means for odors, dusts and particulates to migrate between rooms and floors. Musty odors were detected in the auxiliary gym which is located beneath ground level. Due to its subterranean orientation, the missing bricks can allow an earthy/musty odor to migrate into the auxiliary gym.

## Conclusions/Recommendations

Indoor environmental conditions have improved at OMS, however continued progress is recommended for further improvement. In view of the findings at the time of the visit, the following recommendations are made:

1. Continue with current schedule to fill floor drains (twice a week) to maintain the integrity of the traps. Develop a written protocol (e.g., bi-weekly sign off documents) and ensure that a

designated back-up is available if the designee currently assigned for specific duties is out (ensure drain in room 223 under cabinet is added to current list shown in Picture 4).

2. Work with GDPW officials to establish a notification protocol (e.g., direct phone call) in the event of airborne odors at the pumping station/DPW facility.
3. Extend spigot for computer network AC *into* drain pipe 223 (Picture 4) to prevent spillage.
4. Consult with a licensed plumbing contractor to determine which floor drains are not used or deemed unnecessary and seal these drains permanently.
5. Continue to encourage staff to work with administration and maintenance staff to improve conditions in classrooms and common areas (e.g., water damaged ceiling tiles, plumbing/roof leaks, utility holes, temperature/airflow issues).
6. Make repairs to univents and exhaust vents to ensure they are operating during classroom occupation. To increase airflow, set univent controls to "high".
7. Use openable windows in conjunction with classroom univents and exhaust vents to increase air exchange (during periods of low vehicle activity outside the building). Care should be taken to ensure windows are properly closed at night and weekends to avoid the freezing of pipes and potential flooding.
8. Identify and repair roof leaks in gymnasium, room 223 and the hallway to the skating rink.
9. Replace/repair any remaining water-stained ceiling tiles and building materials. Examine the area above and around these areas for mold growth. Disinfect areas of water leaks with an appropriate antimicrobial.
10. Clean and disinfect walls of room 208 (water streaks) beneath water damaged ceiling tiles.

11. Closely examine water damaged ceiling plaster in gymnasium (Picture 20), determine if area above the water damage is accessible (via catwalk, crawlspace, etc.) to determine if leak causing water damage has been eliminated.
12. Remove or reorganize stored materials to allow easy access to abandoned utilities in the kiln room.
13. Replace missing ceiling tiles and seal utility holes (e.g., art rooms, kiln room); to prevent the egress of drafts, odors and particulate matter into occupied areas.
14. Replace missing blocks or seal holes in auxiliary gym wall and seams around the edges of the floor to mitigate musty odors.
15. Re-wrap damaged fiberglass insulation around pipes in art rooms and other areas.
16. Relocate or consider reducing the amount of materials stored in offices, classrooms and common areas to allow for more thorough cleaning. Clean items regularly with a wet cloth or sponge to prevent excessive dust build-up.
17. Work with gymnasium staff to detail housekeeping improvements. These should include dust control, cleaning of floors, vents and flat surfaces.
18. Consider sealing open seam for unused divider in gym floor to reduce airborne dust and odors.
19. Replace carbon monoxide detectors every 5 years and test monthly to ensure proper working order as per the manufacture's recommendations.
20. Consider posting signs in the student drop off area instructing drivers to shut off engines after five minutes as required by Massachusetts General Laws 90:16A (MGL, 1986).
21. Consider installing charcoal activated filters in perimeter areas to reduce vehicle exhaust odors.

22. Consider discontinuing the use of tennis balls on chair legs to prevent latex dust generation. Alternative "glides" can commonly be purchased from office supply stores; see Picture 28 for an example.

23. Based on the age, physical deterioration and availability of parts of the HVAC system, the MDPH strongly recommends that the HVAC engineering firm fully evaluate the ventilation system for future repair/replacement considerations.

24. Consider adopting the US EPA (2000b) document, "Tools for Schools", to maintain a good indoor air quality environment on the building. This document can be downloaded from the Internet at: http://www.epa.gov/iaq/schools/index.html.

25. Refer to resource manuals and other related indoor air quality documents for further building-wide evaluations and advice on maintaining public buildings. These materials are located on the MDPH's website: http://mass.gov/dph/indoor_air.

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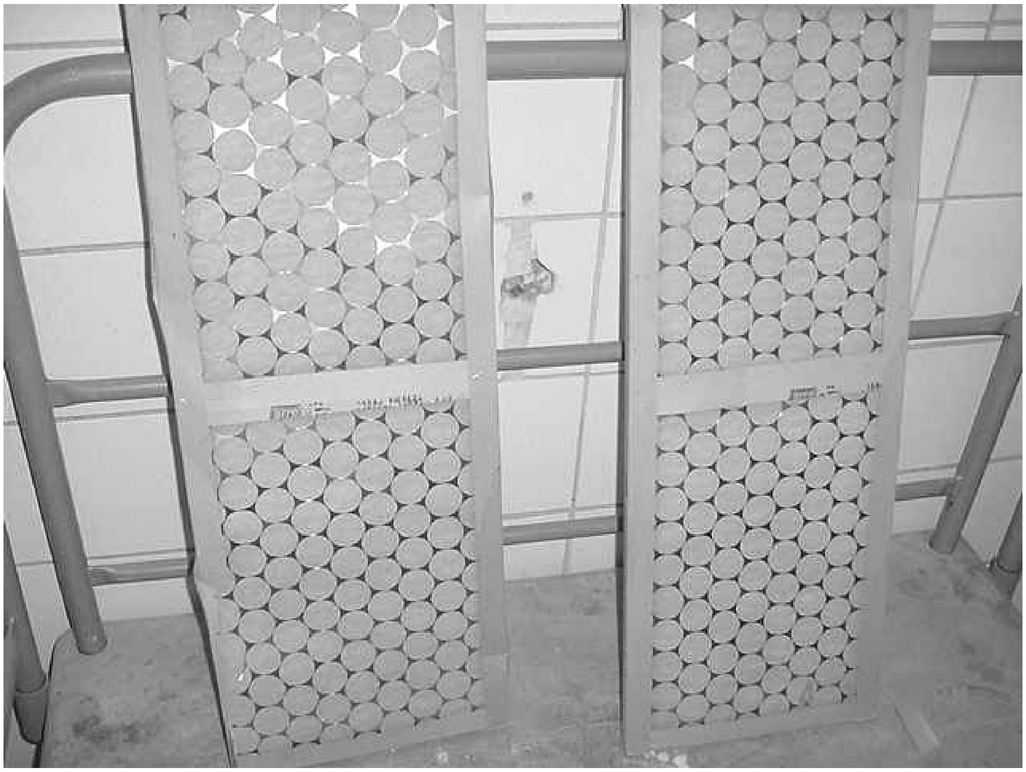
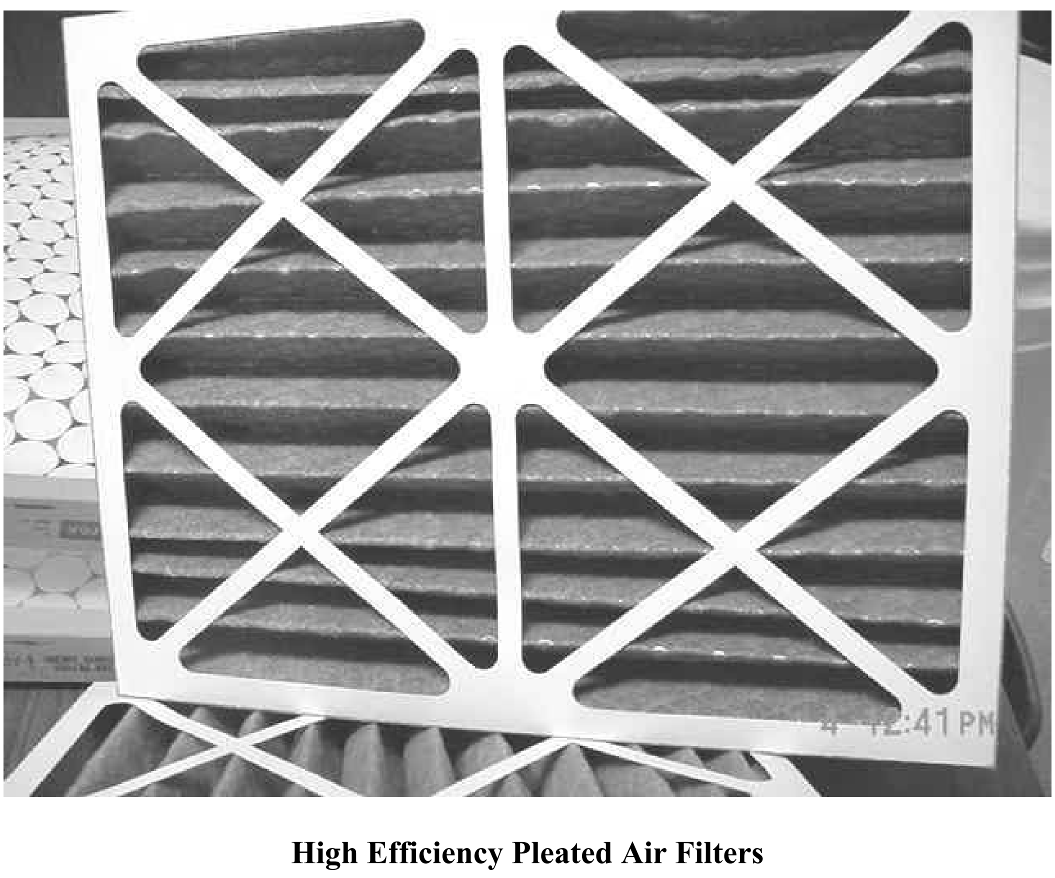
**Picture 1**



**Medium Efficiency Univent Filters**

**Picture 2**



**High Efficiency Pleated Air Filters**

**Picture 3**

**Secondary "Bag" Filtration System**

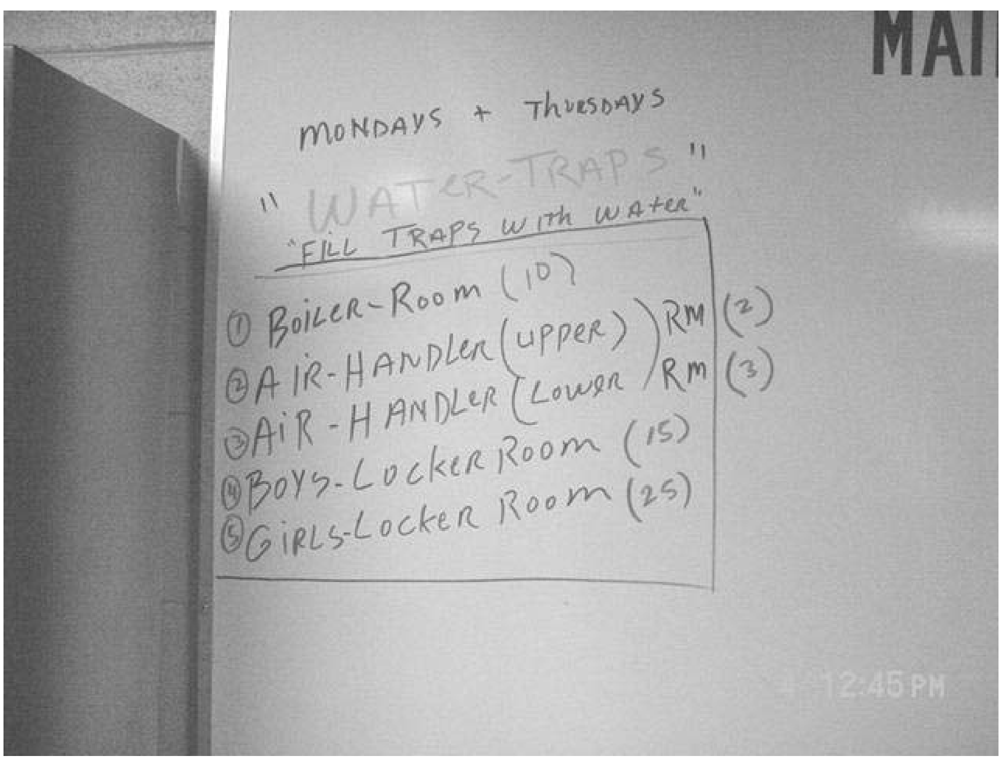
**Picture 4**


**Exterior of Gymnasium Fresh Air Intake, Note Air Intake Faces South in the General Direction of the Pumping Station (Approximately 0.3 Miles to the South/Southwest) see Figure 1**

**Picture 5**


**Typical Floor Drain (one of 55)**

**Picture 6**

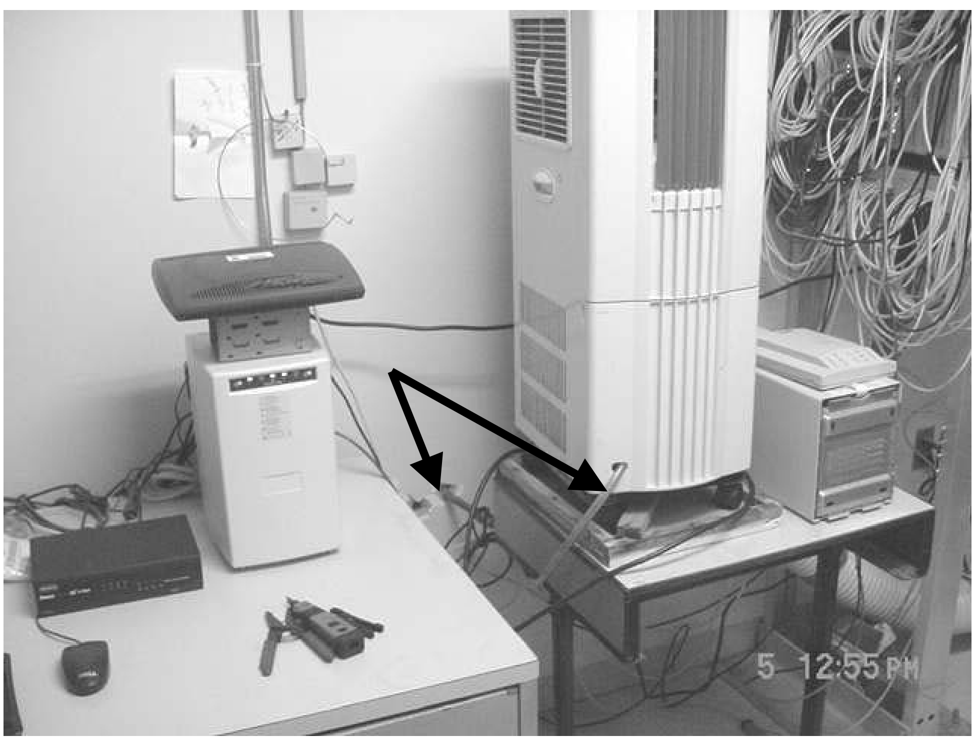



**List of Location and Number of "Water-Traps" (i.e., Floor Drains) on Wall of Maintenance Office and Schedule on top Indicating to Fill Traps Twice a Week**

**Picture 7**

**Drain from AC Unit in Network Room Protruding From Wall Empting into Drain Pipe, Note Shortness of AC Spigot, Which Barely Extends into Drain Pipe**

**Picture 8**

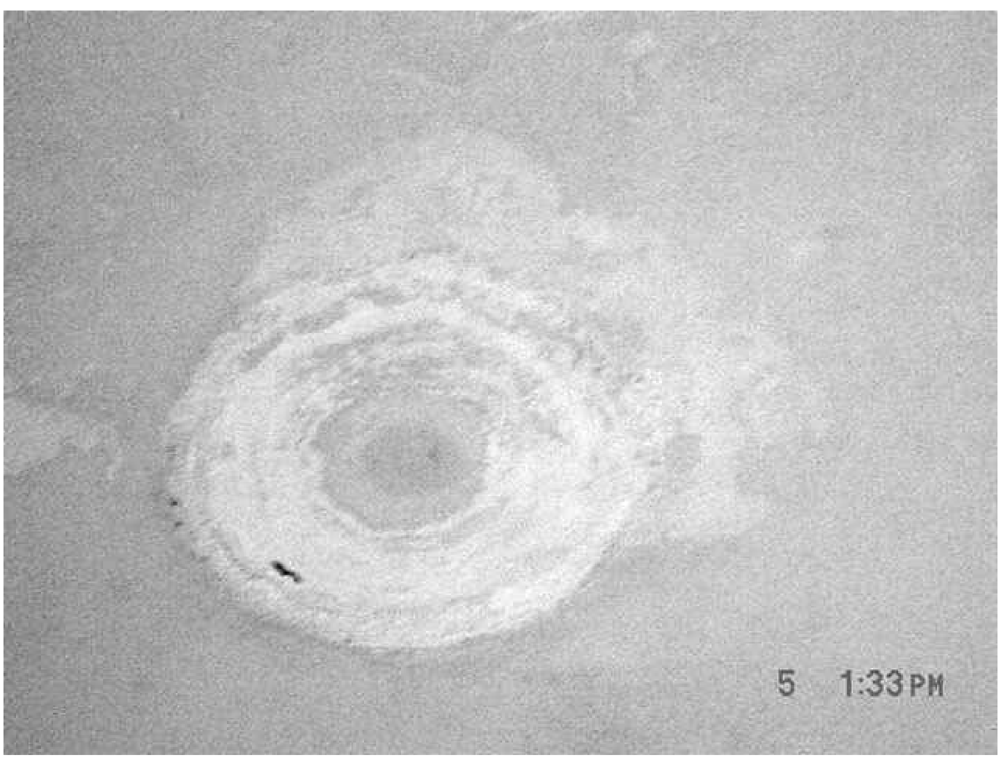



**Portable AC Unit on Table in Network Room Adjacent to Classroom 223, Note Clear Tube Connected to Drain Pipe Protruding Through Wall**

**Picture 9**


**Water Damaged/Mold Colonized Tiles in Skate Storage Room**

**Picture 10**

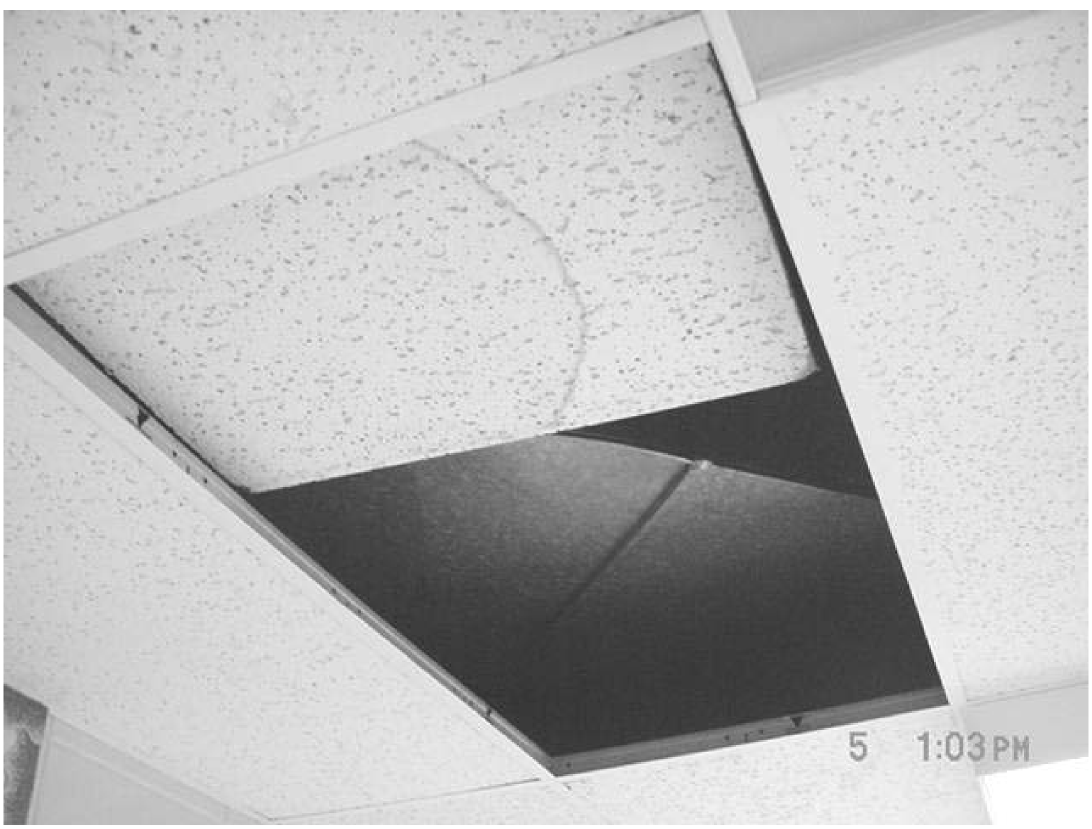



**Water Damaged Ceiling Plaster in Gymnasium**

**Picture 11**

**Elbow Joint/Drain above Water Damaged Ceiling Tiles in Room 223**

**Picture 12**

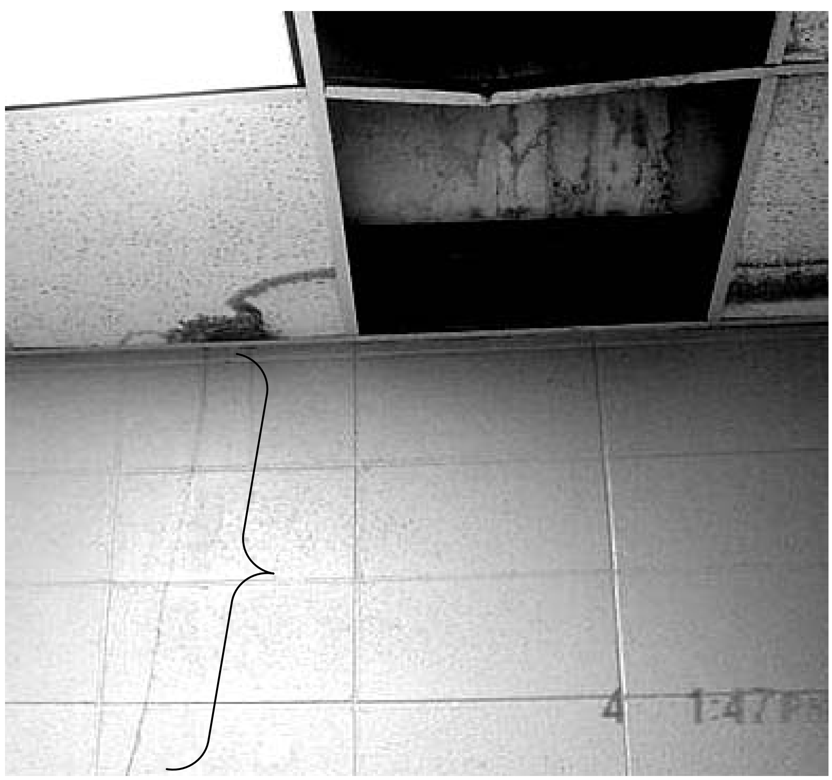



**Sheet Metal Ductwork above Ceiling Tiles in Room 223**

**Picture 13**

**Capped Plumbing Fixtures and Water Damaged Porous Material, Trash and Debris behind Cabinet in Room 223**

**Picture 14**



**Water Damaged/Missing Ceiling Tiles in Room 208, Note Dark Streaks on Wall, Below Stained Tile**

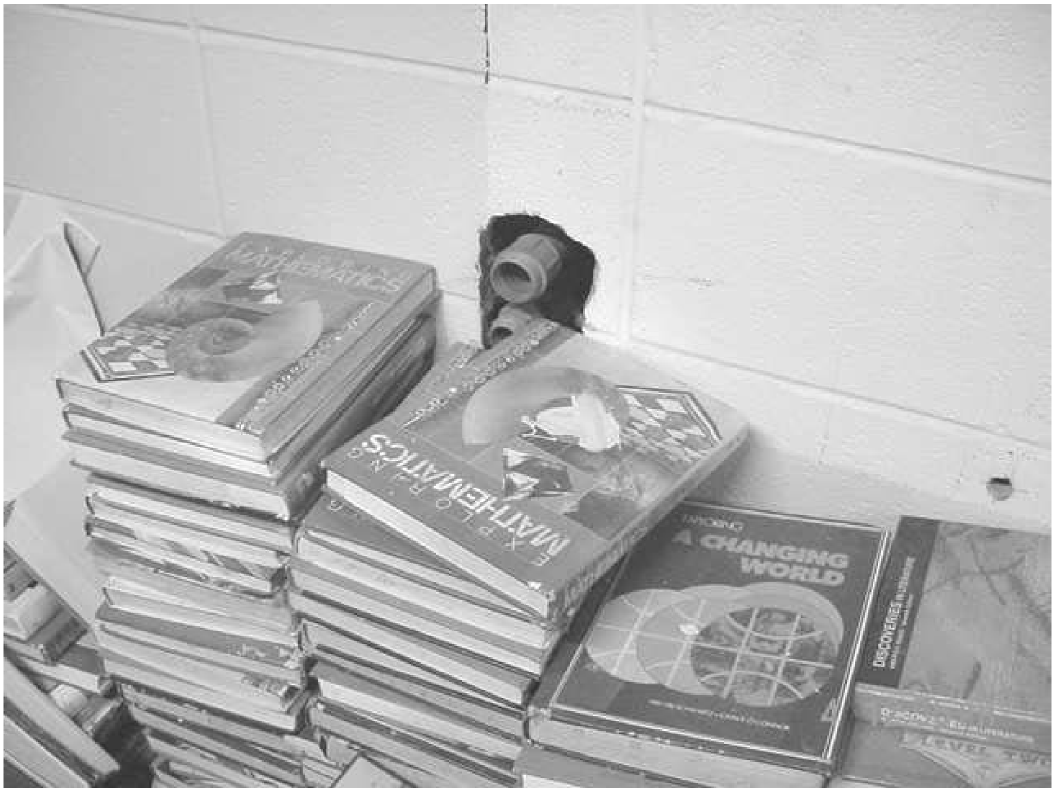
**Picture 15**


**One of Two Carbon Monoxide Detectors in the Gymnasium**

**Picture 16**

**Tennis Balls on Chair Legs in Classroom**

**Picture 17**

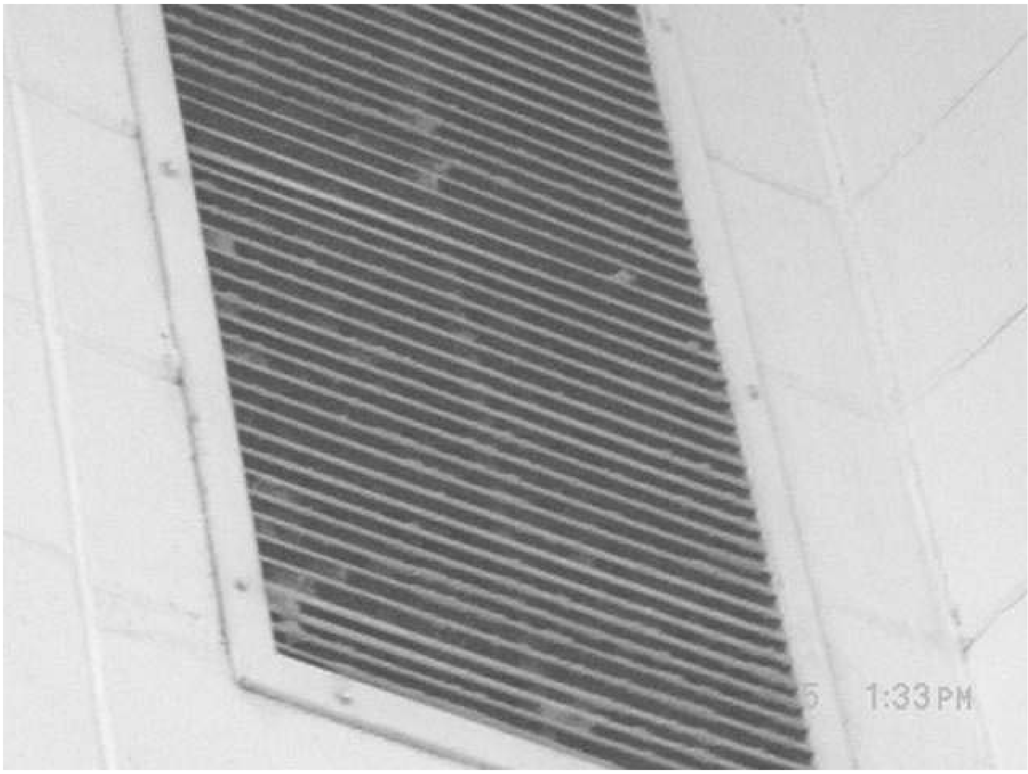



**Open Utility Hole in Kiln Room Wall Separating the Kiln Room from the Boiler Room**

**Picture 18**

**Dirt Dust and Debris on Floor of Gymnasium Storage Room**

**Picture 19**

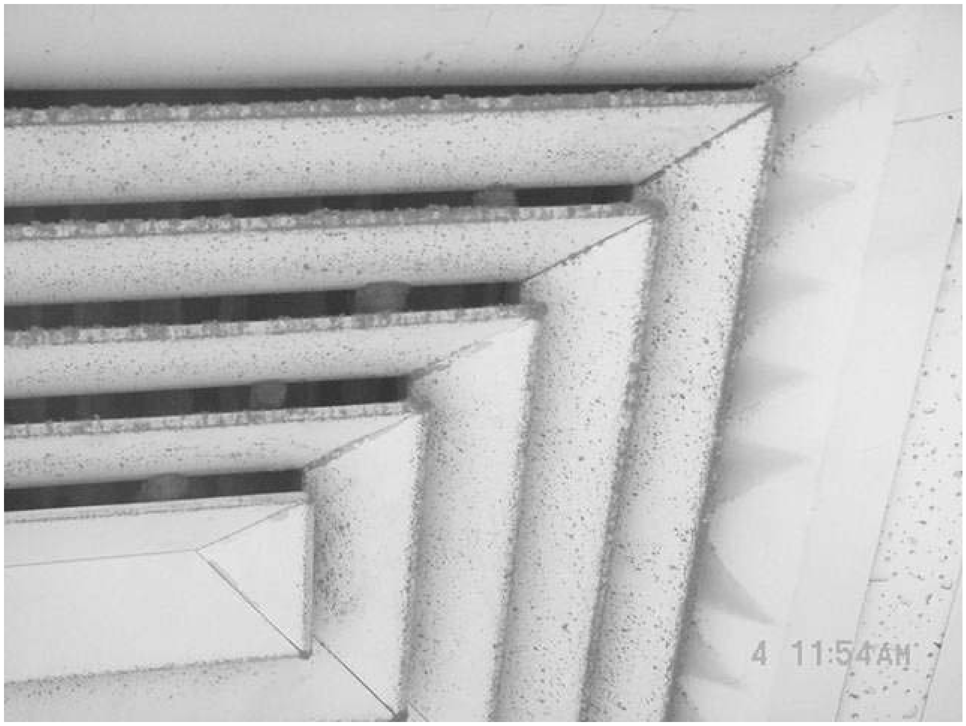


**Dirt Dust and Debris between Louvers of Gymnasium Exhaust Vent**

**Picture 20**

**Dirt Dust and Debris in Track Separating the Gymnasium**

**Picture 21**




**Accumulated Dust on Supply Air Diffuser Room 223**

**Picture 22**


**Accumulated Materials in Kiln Room**

**Picture 23**

(Photo Taken By M. Tracy, Principal of the OMS, 1/9/2006)

**Accumulated Items in Office**

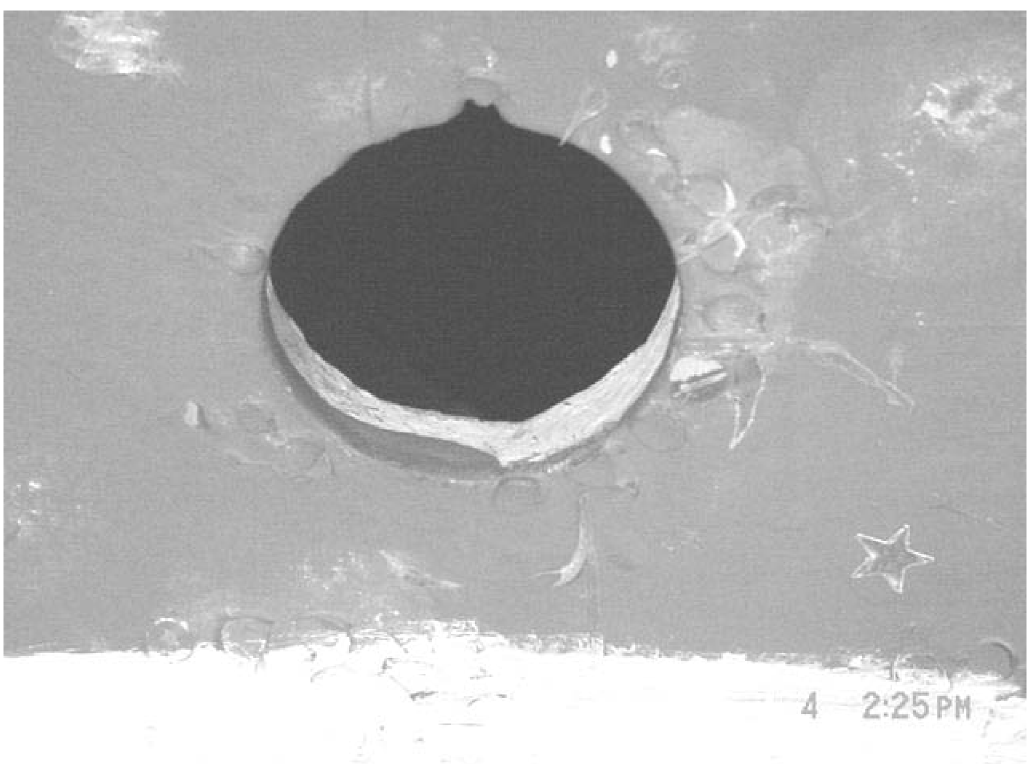
**Picture 24**

**Exposed Fiberglass Insulation around Art Room Heating Pipes**

**Picture 25**

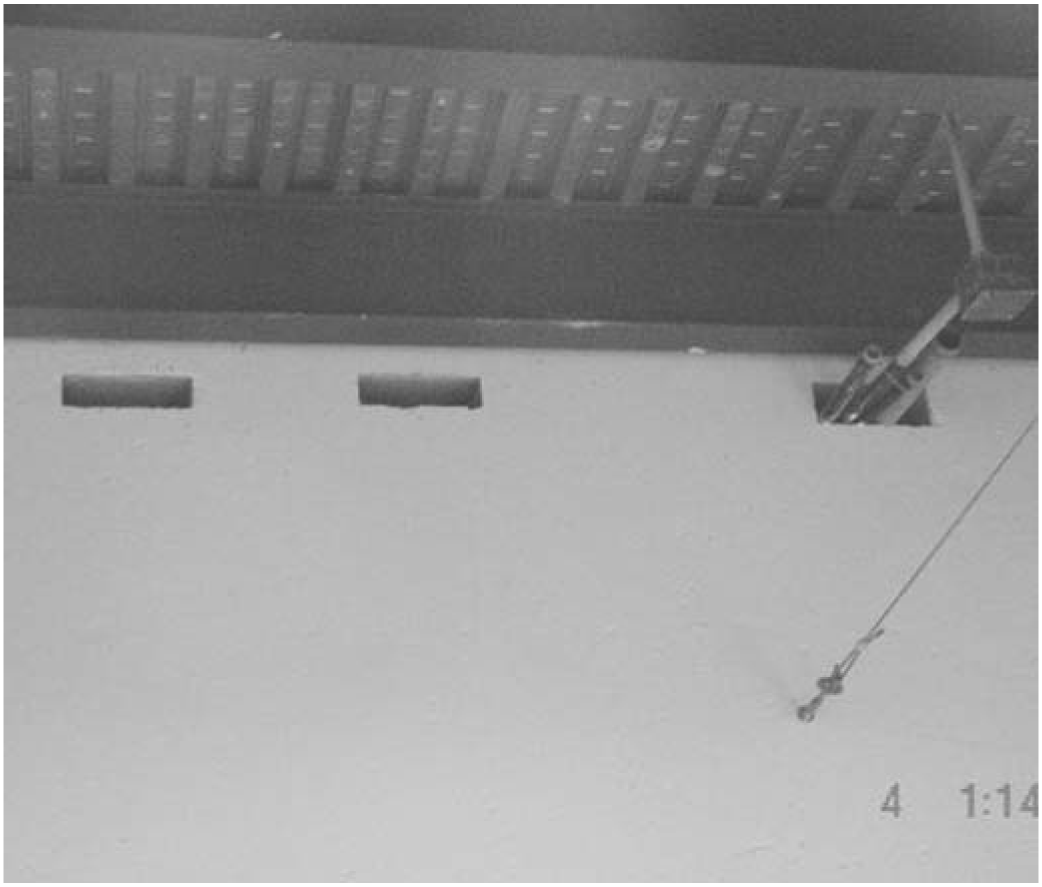

**Hole in Art Room Wall**

**Picture 26**



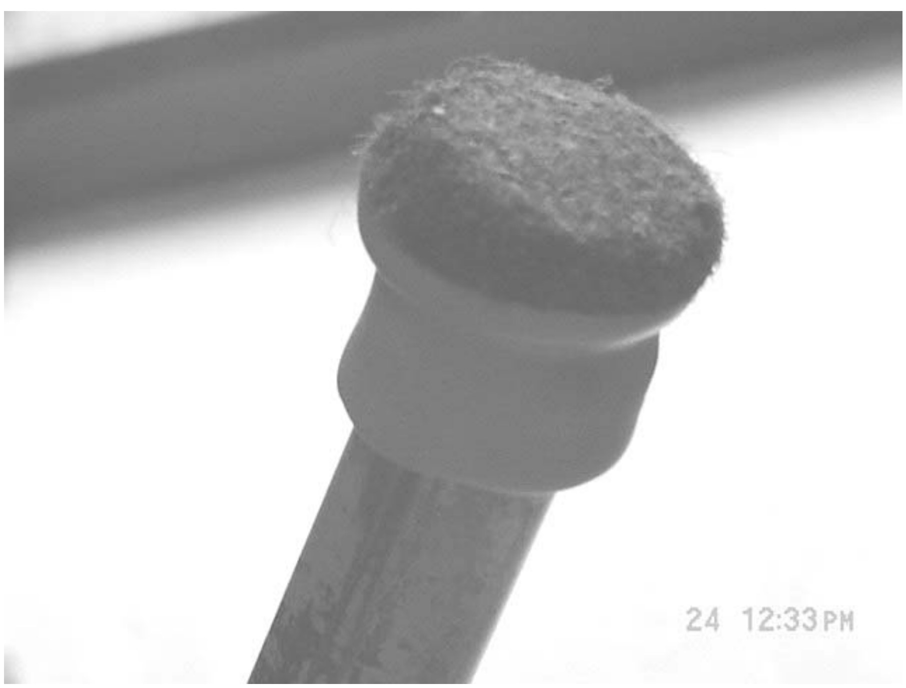

**Open Hole in Art Room Wall**

**Picture 27**




**Holes in Auxiliary Gym Wall**

**Picture 28**




**“Glides” for Chair Legs that can be used as an Alternative to Tennis Balls**

**Ralph B. O'Maley Middle School** | **Indoor Air Results**
**32 Cherry Street, Gloucester, MA 01930** | **Date: 01/04/2006**

# Table 1

| Location/ Room | Occupants in Room | Temp (°F) | Relative Humidity (%) | Carbon Dioxide (ppm) | Carbon Monoxide (ppm) | TVOCs (ppm) | PM2.5 (µg/m3) | Windows Openable | Ventilation | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Supply | Exhaust | |
| Background 9:50 am | 0 | 29 | 76 | 380 | ND | ND | 16 | N | | | cold, cloudy/overcast, NE winds 10-15 mph. UFP 1,500 (p/cc$^3$) |
| gym 11:10am | 45 | 64 | 32 | 574 | ND | ND | 10 | N | Y wall | Y wall dust/debris | Hallway DO, Exterior DO, WD-CP, WD-non-porous material, carbon monoxide monitors on wall, fan blowing air into gym from girl's locker room stairwell with exterior door open. UFP 800 (p/cc$^3$) |
| 223 11:20am | 23 | 68 | 28 | 617 | ND | ND | 4 | N | Y ceiling dust/debris | Y ceiling dust/debris | WD-CT: 2, temperature complaints (cold), temperature complaints (hot), periodic leaks from ceiling reported at front of class, standing water reported from drain overflow in cabinet for computer network AC drain. UFP 600 (p/cc$^3$) |

ppm = parts per million
µg/m3 = micrograms per cubic meter

AD = air deodorizer
AP = air purifier
aqua. = aquarium

AT = ajar ceiling tile
BD = backdraft
CD = chalk dust
CP = ceiling plaster
CT = ceiling tile
DEM = dry erase materials

design = proximity to door
FC = food container
G = gravity
GW = gypsum wallboard
M = mechanical
MT = missing ceiling tile

NC = non-carpeted
ND = non detect
PC = photocopier
PF = personal fan
plug-in = plug-in air freshener
PS = pencil shavings

sci. chem. = science chemicals
TB = tennis balls
terra. = terrarium
UF = upholstered furniture
VL = vent location
WP = wall plaster

**Comfort Guidelines**

Carbon Dioxide: < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems

Temperature: 70 - 78 °F
Relative Humidity: 40 - 60%

**Ralph B. O'Maley Middle School** | **Indoor Air Results**

**32 Cherry Street, Gloucester, MA 01930** | **Table 1** | **Date: 01/04/2006**

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|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Supply | Exhaust | |
| 221 11:25am | 22 | 68 | 34 | 1457 | ND | ND | 30 | Y # open: 0 # total: 2 | Y univent ceiling (off) | Y wall (off) items | WD-CT: 3. UFP 1,000 (p/cc$^3$) |
| 211 11:36 | 4 | 69 | 27 | 623 | ND | ND | 4 | N | Y ceiling | Y ceiling | Hallway DO UFP 600 (p/cc$^3$) |
| 212 11:47am | 19 | 75 | 28 | 707 | ND | ND | 5 | N | Y ceiling | Y ceiling | WD-CT: 2. UFP 300 (p/cc$^3$) |
| 219 11:52am | 21 | 76 | 30 | 1601 | ND | ND | 17 | Y # open: 0 # total: 2 | Y univent | Y wall | DEM, plants, heat complaints, UV-low, Faulty thermostat changed by Dave Anderson, HVAC Tech. GSD. UFP 900 (p/cc$^3$) |
| 218-A 11:59am | 1 | 75 | 24 | 763 | ND | ND | 7 | N | Y ceiling | Y ceiling | Hallway DO, #WD-CT: 1. UFP 2,100 (p/cc$^3$) |
| 218 12:05pm | 22 | 72 | 28 | 1437 | ND | ND | 19 | Y # open: 0 # total: 2 | Y univent | Y wall | nests, plants. UFP 600 (p/cc$^3$) |

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**Ralph B. O'Maley Middle School**

**32 Cherry Street, Gloucester, MA 01930**

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**Indoor Air Results**

**Date: 01/04/2006**

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|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Supply | Exhaust | |
| Art 130 12:10pm | 1 | 69 | 24 | 413 | ND | ND | 5 | N | Y ceiling | Y ceiling | Exterior DO UFP 600 (p/cc$^3$) |
| Art 129 12:30pm | 20 | 67 | 26 | 475 | ND | ND | 14 | N | Y ceiling | Y ceiling | Exterior DO UFP 600 (p/cc$^3$) |
| kiln room 12:45pm | 0 | 68 | 25 | 423 | ND | ND | 21 | N | Y ceiling | Y ceiling | WD-CT: 10, items, hole in wall, boiler room odors UFPs in room 5,300/23,000 at hole. |
| Boy's locker Room 12:55 | 0 | 68 | 27 | 476 | ND | ND | 5 | N | Y ceiling | Y ceiling | WD-CT: 15, drain traps-wet. UFP 500 (p/cc$^3$) |
| auxiliary gym 1:00pm | 0 | 67 | 26 | 458 | ND | ND | 6 | N | Y ceiling | Y ceiling | WD-NC floor, musty odors, holes in wall and around floor edges. UFP 500 (p/cc$^3$) |
| gym 1:15pm | 50 | 67 | 29 | 684 | ND | ND | 10 | N | Y wall | Y wall dust/debris | Hallway DO, WD-CP. UFP 650 (p/cc$^3$) |
| 223 1:20pm | 23 | 69 | 28 | 611 | ND | ND | 6 | N | Y ceiling | Y ceiling | WD-CT: 2. UFP 500 (p/cc$^3$) |

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**Ralph B. O'Maley Middle School**

**32 Cherry Street, Gloucester, MA 01930**

**Indoor Air Results**

**Date: 01/04/2006**

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|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Supply | Exhaust | |
| 208 1:35pm | 1 | 70 | 27 | 694 | ND | ND | 5 | N | Y ceiling | Y ceiling | WD-CT: 7, plumbing leak-fixed, other ceiling leak-water stained wall. UFP 300 (p/cc$^3$) |
| 221 1:40pm | 1 | 69 | 29 | 978 | ND | ND | 19 | Y # open: 0 # total: 2 | Y univent ceiling (off) | Y wall (off) items | UFP 1,600 (p/cc$^3$) |
| 211 1:50pm | 1 | 70 | 26 | 660 | ND | ND | 4 | N | Y ceiling | Y ceiling | Hallway DO UFP 300 (p/cc$^3$) |
| 212 1:54pm | 21 | 75 | 28 | 788 | ND | ND | 5 | N | Y ceiling | Y ceiling | Hallway DO UFP 300 (p/cc$^3$) |
| 219 1:59pm | 23 | 73 | 29 | 1300 | ND | ND | 20 | Y # open: 0 # total: 2 | Y univent | Y wall | DEM, plants. UFP 1,500 (p/cc$^3$) |
| 218 2:04pm | 19 | 72 | 29 | 1326 | ND | ND | 18 | Y # open: 0 # total: 2 | Y univent | Y wall | aqua/terra, plants. UFP 1,000 (p/cc$^3$) |
| 218-A 2:08pm | 1 | 72 | 27 | 780 | ND | ND | 7 | N | Y ceiling | Y ceiling | Hallway DO, #WD-CT: 1. UFP 900 (p/cc$^3$) |

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**Comfort Guidelines**

| | | | |
|---|---|---|---|
| Carbon Dioxide: | < 600 ppm = preferred | Temperature: | 70 - 78 °F |
| | 600 - 800 ppm = acceptable | Relative Humidity: | 40 - 60% |
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**Ralph B. O'Maley Middle School**

**32 Cherry Street, Gloucester, MA 01930**

# Table 1

**Indoor Air Results**

**Date: 01/04/2006**

| Location/ Room | Occupants in Room | Temp (°F) | Relative Humidity (%) | Carbon Dioxide (ppm) | Carbon Monoxide (ppm) | TVOCs (ppm) | PM2.5 (µg/m3) | Windows Openable | Ventilation | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Supply | Exhaust | |
| Art 129 2:11pm | 0 | 70 | 28 | 1054 | ND | ND | 39 | N | Y ceiling | Y ceiling | MT/AT: 12, occupants gone 5 min, exposed fiberglass insulation above CTs and around radiator pipes-rear, utility holes in walls. UFP 1,000 ($p/cc^3$) |
| 130 2:16pm | 0 | 69 | 25 | 453 | ND | ND | 10 | N | Y | Y ceiling | Hallway DO, #WD-CT: 2. UFP 700 ($p/cc^3$) |
| boiler room 2:25 | 0 | 70 | 20 | 450 | ND | ND | 24 | N | Y | Y wall | WD-CT: 10, items. UFP 18,500 ($p/cc^3$) |
| kiln room 2:29pm | 0 | 68 | 25 | 450 | ND | ND | 12 | N | Y ceiling | Y ceiling | WD-CT: 10, boiler room odors from hole in wall/boiler room). UFP 2,400 ($p/cc^3$) |
| Boy's locker Room 2:35pm | 1 | 68 | 27 | 501 | ND | ND | 5 | N | Y ceiling | Y ceiling | UFP 400 ($p/cc^3$) |
| auxiliary gym 2:49pm | 0 | 68 | 27 | 493 | ND | ND | 5 | N | Y ceiling | Y ceiling | musty odors, holes in wall and around floor edges. UFP 400 ($p/cc^3$) |

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**Ralph B. O'Maley Middle School** | **Indoor Air Results**

**32 Cherry Street, Gloucester, MA 01930** | **Date: 01/05/2006**

# Table 2

| Location/ Room | Occupants in Room | Temp (°F) | Relative Humidity (%) | Carbon Dioxide (ppm) | Carbon Monoxide (ppm) | TVOCs (ppm) | PM2.5 (µg/m3) | Windows Openable | Ventilation | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Supply | Exhaust | |
| 8:15 am background | 0 | 24 | 71 | 426 | ND | ND | 48 | N | | | Mostly cloudy, south winds 5-10 mph, light precipitation, combustion odors (e.g., fire place/chimney exhaust, vehicle exhaust). UFP 24,000 (p/cc$^3$) |
| 221 8:18 am | 5 | 60 | 47 | 978 | ND | ND | 28 | N | Y univent (off) | Y wall (off) | WD-CT: 2. UFP 5,700 (p/cc$^3$) |
| 222 8:24 am | 2 | 65 | 36 | 541 | ND | ND | 5 | N | Y ceiling | Y ceiling | WD-CT: 2. UFP 2,400 (p/cc$^3$) |
| 211 8:30 am | 6 | 68 | 33 | 625 | ND | ND | 6 | N | Y ceiling | Y ceiling | UFP 2,500 (p/cc$^3$) |
| 221 8:35 am | 21 | 75 | 33 | 726 | ND | ND | 5 | N | Y ceiling | Y ceiling | WD-CT: 2, DEM. UFP 1,700 (p/cc$^3$) (8,900 p/cc$^3$ outside) |
| 219 8:40am | 21 | 70 | 33 | 1228 | ND | ND | 20 | Y # open: 0 # total: 2 | Y univent | Y wall | Hallway DO, plants. UFP 1,500 (p/cc$^3$) |
| 218 A 8:45 am | 2 | 70 | 31 | 790 | ND | ND | 8 | N | Y univent | Y wall | Hallway DO UFP 2,200 (p/cc$^3$) |

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**Ralph B. O'Maley Middle School**

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**Table 2**

**Indoor Air Results**

**Date: 01/05/2006**

| Location/ Room | Occupants in Room | Temp (°F) | Relative Humidity (%) | Carbon Dioxide (ppm) | Carbon Monoxide (ppm) | TVOCs (ppm) | PM2.5 (µg/m3) | Windows Openable | Ventilation | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Supply | Exhaust | |
| 218 8:50 am | 17 | 70 | 33 | 1174 | ND | ND | 18 | Y<br># open: 0<br># total: 2 | Y<br>univent | Y<br>wall | plants. UFP 2,100 (p/cc$^3$) |
| gym 8:56 am | 50 | 69 | 29 | 563 | ND | ND | 12 | N | Y<br>wall | Y<br>wall | Inter-room DO UFP 5,700 (p/cc$^3$) |
| auditorium 9:01 am | 0 | 70 | 30 | 449 | ND | ND | 11 | N | Y<br>ceiling | Y<br>wall | White dusty material on back wall-grating, moisture measurements-low (i.e., normal). UFP 5,600 (p/cc$^3$) |
| 223 9:10 am | 22 | 70 | 30 | 626 | ND | ND | 6 | N | Y<br>ceiling | Y<br>ceiling | Occupant reports periodic standing water on floor near storage cabinet/interior wall, computer network AC drain under cabinet-drain pipe too short-overflow. UFP 1,600 (p/cc$^3$) |

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**Ralph B. O'Maley Middle School**

**32 Cherry Street, Gloucester, MA 01930**

# Table 2

**Indoor Air Results**

**Date: 01/05/2006**

| Location/ Room | Occupants in Room | Temp (°F) | Relative Humidity (%) | Carbon Dioxide (ppm) | Carbon Monoxide (ppm) | TVOCs (ppm) | PM2.5 (µg/m3) | Windows Openable | Ventilation | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Supply | Exhaust | |
| 129 9:15 am | 25 | 70 | 31 | 813 | ND | ND | 19 | N | | | Exterior DO, occupant reports periodic leaks-plumbing above CT, exposed fiberglass insulation-pipe wrap, open utility holes/wall. UFP 3,900 (p/cc$^3$) |
| 130 9:19 am | 28 | 69 | 30 | 554 | ND | ND | 31 | N | Y ceiling | Y ceiling | Hallway DO, Inter-room DO UFP 1,600 (p/cc$^3$) |
| boy's locker room 9:25 am | 3 | 69 | 30 | 491 | ND | ND | 5 | N | Y ceiling | Y ceiling | UFP 1,600 (p/cc$^3$) |
| auxiliary gym 9:29 am | 0 | 68 | 29 | 461 | ND | ND | 4 | N | Y ceiling | Y ceiling | Musty odor, dust, open breaches in cinder block wall. UFP 1,500 (p/cc$^3$) |
| main office 12:55 pm | 1 | 69 | 36 | 650 | ND | ND | 12 | N | Y ceiling | Y ceiling | UFP 1,600 (p/cc$^3$) |
| 221 1:00 pm | 15 | 69 | 42 | 1304 | ND | ND | 29 | Y # open: 0 # total: 2 | Y univent (off) | Y wall (off) | Hallway DO, #WD-CT: 3. UFP 1,600 (p/cc$^3$) |

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Relative Humidity: 40 - 60%

**Ralph B. O'Maley Middle School** **Indoor Air Results**

**32 Cherry Street, Gloucester, MA 01930** **Table 2** **Date: 01/05/2006**

| Location/ Room | Occupants in Room | Temp (°F) | Relative Humidity (%) | Carbon Dioxide (ppm) | Carbon Monoxide (ppm) | TVOCs (ppm) | PM2.5 (µg/m3) | Windows Openable | Ventilation | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Supply | Exhaust | |
| 222 1:05 pm | 7 | 68 | 35 | 646 | ND | ND | 4 | N | Y ceiling | Y ceiling | DEM. UFP 700 (p/cc$^3$) |
| 223 1:10 pm | 23 | 70 | 35 | 612 | ND | ND | 7 | N | Y ceiling | Y ceiling | WD-CT: 2, DEM, old water damaged materials under cabinet/sinks-capped. UFP 900 (p/cc$^3$) |
| gym and storeroom 1:20 pm | 50 | 66 | 34 | 535 | ND | ND | 9 | N | Y ceiling | Y wall | dust, items, active roof leak-rear stairwell, dust accumulation storeroom and track divider across gym UFP 1,200 (p/cc$^3$) |
| Ms. G's room 1:25 pm | 0 | 67 | 35 | 545 | ND | ND | 7 | Y # open: 0 # total: 1 | Y ceiling | Y ceiling | DEM, plants. UFP 1,000 (p/cc$^3$) |
| 211 1:30 pm | 3 | 69 | 35 | 634 | ND | ND | 4 | N | Y ceiling | Y ceiling | Hallway DO, items hanging from CT. UFP 700 (p/cc$^3$) |
| 212 1:35 pm | 0 | 73 | 35 | 683 | ND | ND | 5 | N | Y ceiling | Y ceiling | WD-CT: 2, DEM. UFP 800 (p/cc$^3$) |

ppm = parts per million
µg/m3 = micrograms per cubic meter

AD = air deodorizer
AP = air purifier
aqua. = aquarium

AT = ajar ceiling tile
BD = backdraft
CD = chalk dust
CP = ceiling plaster
CT = ceiling tile
DEM = dry erase materials

design = proximity to door
FC = food container
G = gravity
GW = gypsum wallboard
M = mechanical
MT = missing ceiling tile

NC = non-carpeted
ND = non detect
PC = photocopier
PF = personal fan
plug-in = plug-in air freshener
PS = pencil shavings

sci. chem. = science chemicals
TB = tennis balls
terra. = terrarium
UF = upholstered furniture
VL = vent location
WP = wall plaster

**Comfort Guidelines**

Carbon Dioxide: < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems

Temperature: 70 - 78 °F
Relative Humidity: 40 - 60%

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**32 Cherry Street, Gloucester, MA 01930** | **Date: 01/05/2006**

## Table 2

| Location/ Room | Occupants in Room | Temp (°F) | Relative Humidity (%) | Carbon Dioxide (ppm) | Carbon Monoxide (ppm) | TVOCs (ppm) | PM2.5 (µg/m3) | Windows Openable | Ventilation | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Supply | Exhaust | |
| 219 1:40 pm | 19 | 70 | 36 | 1188 | ND | ND | 17 | Y # open: 0 # total: 2 | Y univent | Y wall | DEM. UFP 2,400 (p/cc$^3$) |
| 130 1:45 pm | 24 | 70 | 33 | 719 | ND | ND | 19 | N | Y ceiling | Y ceiling | Exterior DO UFP 2,800 (p/cc$^3$) |
| 218 1:50 pm | 22 | 70 | 37 | 1327 | ND | ND | 21 | Y # open: 0 # total: 2 | Y univent | Y wall | Aqua/terra, plants. UFP 2,100 (p/cc$^3$) |
| 129 1:55 pm | 24 | 69 | 34 | 559 | ND | ND | 43 | N | Y ceiling | Y ceiling | UFP 2,700 (p/cc$^3$) |
| kiln room 2:00 pm | 0 | 70 | 33 | 587 | ND | ND | 52 | N | Y ceiling | Y ceiling | Hallway DO, #WD-CT: 10, hole in wall, boiler room odors UFP 3,200 (p/cc$^3$) |
| 109 2:05 pm | 0 | 71 | 33 | 618 | ND | ND | 5 | N | Y ceiling dust/debris | Y ceiling dust/debris | Hallway DO, #WD-CT: 5, #MT/AT: 2, DEM. UFP 800 (p/cc$^3$) |
| boy's locker room 2:10 pm | 0 | 66 | 35 | 489 | ND | ND | 5 | N | Y ceiling | Y ceiling | UFP 800 (p/cc$^3$) |

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|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Supply | Exhaust | |
| auxiliary gym 2:15 pm | 0 | 67 | 37 | 511 | ND | ND | 5 | N | Y ceiling | Y ceiling | UFP 900 (p/cc$^3$) |
| skate room 2:20 pm | 0 | 68 | 39 | 510 | ND | ND | 7 | N | N | N | #WD-CT: 5, #CT- mold: 1, #MT/AT: 5. UFP 900 (p/cc$^3$) |

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**Comfort Guidelines**

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|---|---|---|---|
| Carbon Dioxide: | < 600 ppm = preferred | Temperature: | 70 - 78 °F |
| | 600 - 800 ppm = acceptable | Relative Humidity: | 40 - 60% |
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Figure 1
Location of Ralph B. O'Maley Middle School and Gloucester DPW
Gloucester, MA




Geographic data supplied by:
Massachusetts Executive Office of Environmental Affairs, MassGIS; Geographic Data Technology, Inc.

**Figure 2**
**Aerial View O'Maley Middle School**


**Note Access Road on Hill and Hairpin Turn Parallel to School which forms a "Basin" Between the Hill and Building**